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Chromosome Numbers of *Thelypteris torresiana* (Gaudich.) Alston and *T. viridifrons* Tagawa (Thelypteridaceae)

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In Japanese populations, *Thelypteris torresiana* var. *torresiana* was found to be tetraploid with 2n = 124, contrasting with var. *calvata* which is diploid with 2n = 62. A cytogeographical distribution map of the *T. torresiana* complex is presented. The chromosome number of *T. viridifrons* was 2n = 122, which appears to be derived from 2n = 124, a tetraploid based on x = 31.

Key words: aneuploidy, chromosome number, cytogeography, *Macrothelypteris*, *Thelypteris*.

According to Iwatsuki (1995), the section Macrothelypteris of the subgenus Thelypteris in the genus *Thelypteris* in Japan is characterized by tripinnate or more compound fronds, and includes three species, i. e., *T. torresiana* (Gaudich.) Alston distributed mainly in East and Southeast Asia as far as Australia, and also naturalized in the New World, *T. ogasawarensis* (Nakai) H.Ito ex Honda endemic to the Bonin and Volcano Islands, and *T. viridifrons* Tagawa from East Asia. *Thelypteris ogasawarensis* has been recorded as diploid with n = 31 (Mitui 1973), and *T. viridifrons* as tetraploid, imprecisely counted as n = 61–62 (Kurita 1961).

As for *T. torresiana*, Iwatsuki (1965, 1995) subdivided this species into two varieties; var. *torresiana* having dense multicellular hairs on the laminae, and var. *calvata* (Baker) K.Iwats. having sparse, mostly unicellular hairs. However, the nomenclature of the *T. torresiana* complex has been rather complicated, and various synonyms were applied in previous cytological studies as shown in Table 1. These studies revealed that *T. torresiana* is basically a diploid-tetraploid complex based on x = 31, the single exception being the hexaploid with n = 93 from Sri Lanka (cf. Hirabayashi 1969, Walker 1985).

The present paper reports further chromosome counts for the *T. torresiana* complex and *T. viridifrons* in some Japanese populations, and also presents a cytogeographic map for the *T. torresiana* complex.

Materials and Methods

The collecting localities, chromosome numbers and voucher specimens of the materials are given in Table 2. Methods for chromosome observations were the same as described in Nakato (1998). Voucher specimens are deposited in the herbarium of the Botanical Gardens, University of Tokyo (TI).

Results and Discussion

1. **Thelypteris torresiana** (Gaudich.)

Table 1. Nomenclature of the *Thelypteris torresiana* complex and references of cytological studies

Nomenclature	References
Thelypteris torresiana (Gaudich.) Alston	Mitui (1976), Bhavanandan (1981), Smith and Foster (1984), Tsai and Shieh (1985), Nakato (1987), the present study
= *T. uliginosa* (Kunze) Ching	Manton (1954), Manton and Sledge (1954), Mehra (1961), Abraham et al. (1962), Ghatak (1962), Walker (1966)
= *Macrothelypteris torresiana* (Gaudich.) Ching	Khullar et al. (1983), Walker (1985), Weng (1990), Loyal (1991), Irdayaraj and Manickam (1995), Kato and Nakato (1999)
= *Lastrea tenericaulis* (Wall. ex Hook.) T.Moore	Kurizono (1987)
Thelypteris torresiana var. calvata (Baker) K.Iwats.	the present study
= *T. oligophlebia* (Baker) Ching var. *elegans* (Koidz.) Tagawa	Hirabayashi (1969)
= *Lastrea oligophlebia* (Baker) Copel. var. *elegans* (Koidz.) Tagawa	Mitui (1968)
= *Macrothelypteris oligophlebia* (Baker) Ching var. *elegans* (Koidz.) Ching	Chiu (1981)

Table 2. List of taxa, localities, chromosome numbers and voucher specimens

Taxon Chromosome number, base number, ploidy level Locality	Specimen no. (Nakato no.)
Thelypteris torresiana (Gaudich.) Alston var. *torresiana*	
2n = 124, x = 31, 4x	
Yamato-son, Amamioshima Isl., Kagoshima Prefecture.	no. 2353
Benoki, Kunigami-son, Okinawa Prefecture.	no. 2403**
Yonaha-dake, Kunigami-son, Okinawa Prefecture.	no. 2412**
Ogimi-son, Okinawa Prefecture.	no. 2420
Thelypteris torresiana (Gaudich.) Alston var. *calvata* (Bak.) K.Iwats.	
2n = 62, x = 31, 2x	
Motosyuku, Hinohara-mura, Tokyo Prefecture.	no. 1069
Eiheiji, Eiheiji-cho, Yoshida-gun, Fukui Prefecture.	nos. 1911, 1912
Yugashima, Amagiyugashima-cho, Shizuoka Prefecture.	no. 2387**
Murou, Murou-mura, Uda-gun, Nara Prefecture.	no. 2427
Yuki, Yuki-cho, Saiki-gun, Hiroshima Prefecture.	no. 2440
Kaina, Sakawa-cho, Takaoka-gun, Kochi Prefecture.	no. 2371**
Tashiro, Sakawa-cho, Takaoka-gun, Kochi Prefecture.	no. 2373
Thelypteris viridifrons Tagawa	
2n = 122*, aneuploid probably derived from x = 31, 4x	
Zenpukuji, Suginami-ku, Tokyo Prefecture.	no. 2392**
Narahashi, Higashiyamato-shi, Tokyo Prefecture.	nos. 2376, 2377**, 2397**
Hayashida, Tosayamada-cho, Kami-gun, Kochi Prefecture.	no. 2374
Toyokawainari, Toyokawa-shi, Aichi Prefecture.	no. 2423

*The first precise count for the species.

**Specimens with 64-spore sporangia; others not examined.

Alston complex

Out of the ten individuals examined, four plants from four localities were found to be tetraploid with 2n = 124 (Fig. 1 A, B), and eight plants from seven localities to be diploid with 2n = 62 (Fig. 1 C, D). The tetraploid individuals commonly had dense multicellular (usually 4 to 6 cells) hairs about 1–2 mm in length, whereas the diploid plants showed some individual variation in the density of hairs, with hairs on the abaxial surface of the frond being unicellular or two-celled up to about 1.0 mm in length. On the basis of these characters, the tetraploid individuals observed in this study were assigned to var. *torresiana*, and the diploid to var. *calvata*.

For *T. torresiana* var. *torresiana*, previous

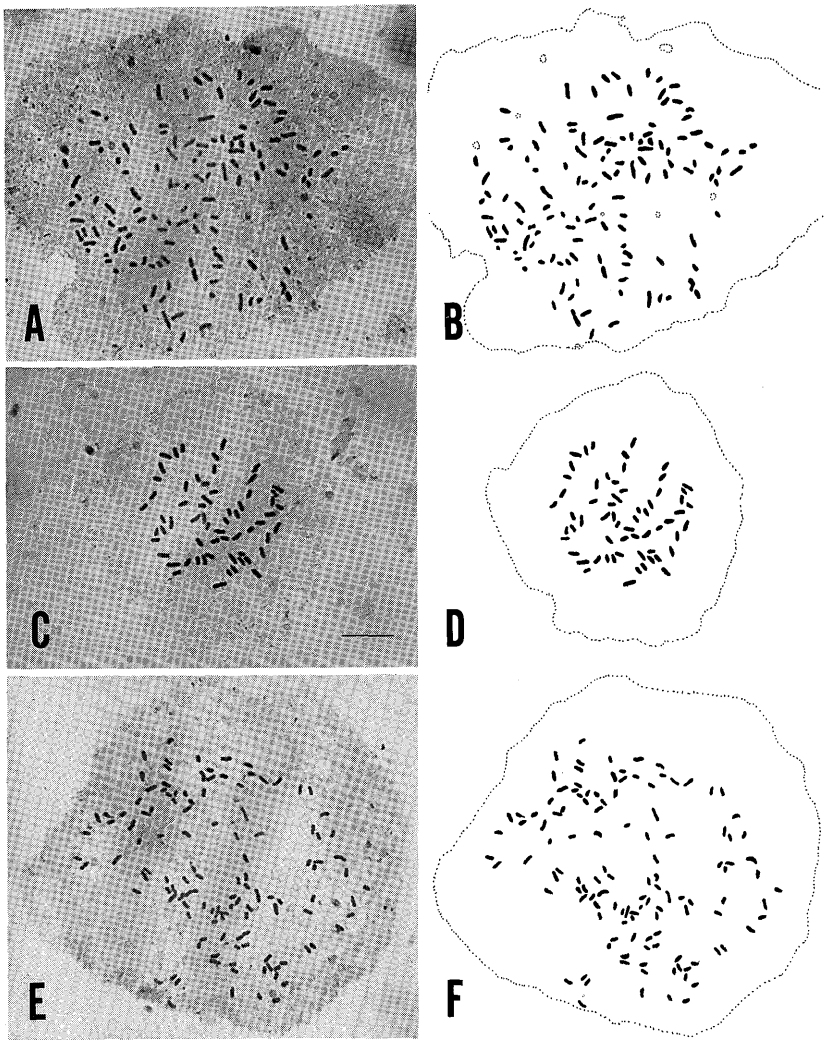

Fig. 1. Microphotographs of somatic chromosomes and explanatory drawings. A, B: *Thelypteris torresiana* var. *torresiana*, 2n = 124, no. 2353. C, D: *T. torresiana* var. *calvata*, 2n = 62, no. 2440. E, F: *T. viridifrons*, 2n = 122, no. 2397. Scale bar = 10 μm.

chromosome studies reported n = 62 and/or 2n = 124, tetraploid based on x = 31, from various regions: Yakushima Isl. and Ishigakijima Isl., Japan (Nakato 1987), Amamioshima Isl., Japan (Kurizono 1987), Hangzhou, Zhejiang, China (Weng 1990), Hainan, China (Kato and Nakato 1999), Western Ghats, India (Abraham et al. 1962, Bhavanandan 1981, Irdayaraj and Manickam 1995), Darjeeling, eastern Himalaya (Mehra 1961, Khullar et al. 1983, Loyal 1991), W. Bengal, India (Ghatak 1962), Sri Lanka (Manton and Sledge 1954), Singapore (Manton 1954), Jamaica (Walker 1966), Trinidad (Walker 1985) and Paraguay (Smith and Foster 1984). In addition, Manickam (1984) reported the chromosome number n = 62 for *T. torresiana* from the Palni Hills, south India, under the name of *Macrothelypteris ornata* (Wall. ex Bedd.) Ching (see Manickam and Irdayaraj 1992). On the other hand, a diploid cytotype with n = 31 in var. *torresiana* was recorded from Ishigakijima Isl., Japan (Mitui 1976) and Nantou, Taiwan (Tsai and Shieh 1985), and a hexaploid with n = 93 from Sri Lanka (Manton 1954).

In var. *calvata*, a diploid was recorded from Mt. Takaosan, Tokyo, Japan (Hirabayashi 1969), and a tetraploid from plants of unknown origin cultivated in Tokyo University of Education (Mitui 1968), and Hangzhou, Zhejian, China (Chiu 1981).

Thus, the present and previous studies suggested the existence of diploid and tetraploid cytotypes both in var. *torresiana* and in var. *calvata*, though neither the diploid of var. *torresiana* nor the tetraploid of var. *calvata* was confirmed in the present study. Moreover, it is inferred that, in var. *calvata* from Japan, diploids have a wider range than tetraploids. Figure 2 shows the occurrences of the three cytotypes and the distribution range of the *T. torresiana* complex. The range is illustrated based on the reports of Holttum (1974), Jacobsen (1983), Smith and Foster (1984), Kurata and Nakaike (1993), Smith (1993), Wilson (1996), de Lange and Crowcroft (1997), Bostock (1998), Shing et al. (1999) and Khullar (2000). The available data revealed that the diploid cytotype of *T. torresiana* complex has a narrow distribution range restricted to Japan and Taiwan, whereas the tetraploid is widespread in Asia and America. It should be noted that only the tetraploid cytotype has extended its range and become naturalized in the New World tropics.

2. **Thelypteris viridifrons** Tagawa

A single previous chromosome count showed that this species was a tetraploid with n = 61–62 (Kurita 1961). In the present study, an accurate chromosome number, 2n = 122, was revealed for the first time in six individuals; four from Tokyo Prefecture, one from Aichi Prefecture and one from Kochi Prefecture. (Fig. 1E, F). The chromosome number 2n = 122 is unique, as it does not fit with any basic chromosome numbers previously reported in the family Thelypteridaceae, in which a series of basic chromosome numbers, x = 27, 30, 31, 32, 34, 35 and 36, has been known (Walker 1984). Iwatsuki (1965) stated that *T. torresiana*, *T. ogasawarensis* and *T. viridifrons* are closely related to each other, and that *T. viridifrons* is a northern variant of *T. torresiana*. As both *T. torresiana* and *T. ogasawarensis* have chromosome numbers in multiples of x = 31, the number 2n = 122 of *T. viridifrons* seems most probably to have been derived from aneuploidal reduction from the tetraploid number 2n = 124 based on x = 31.

Aneuploids in ferns have usually been found only rarely in euploid populations or in narrow areas, neverthless the reverse case was recorded in *Thelypteris laxa* (Franch. & Sav.) Ching, in which the aneuploid cytotype with 2n = 134 appeared to have a wider distribution range than the eutetraploid cytotype

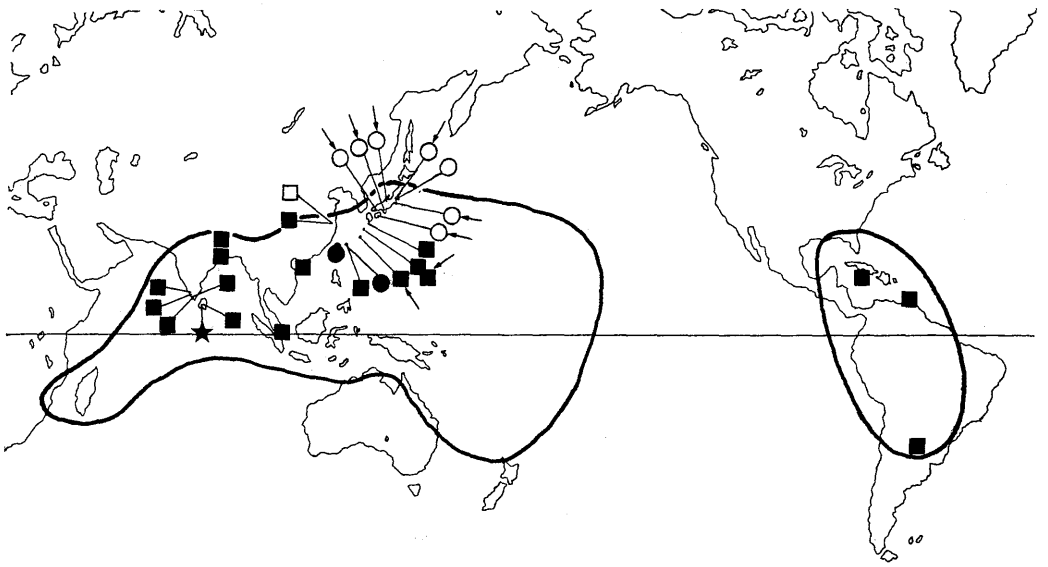

Fig. 2. Distribution of cytotypes in the *T. torresiana* complex. Var. *torresiana*: ●, diploid. ■, tetraploid. ★, hexaploid. Var. *calvata*: ○, diploid. □, tetraploid. Arrows indicate the specimens examined in the present study.

with 2n = 136, x = 34 (Nakato 1998). The situation of the cytology of *T. viridifrons* may resemble that of *T. laxa*, although only the 2n = 122 plants of aneuploid origin have been discovered so far.

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中藤成実：アラゲヒメワラビ群とミドリヒメワラビの染色体数

アラゲヒメワラビは旧世界の熱帯域を中心に分布しているヒメシダ科のシダで，細胞学的には染色体基本数 x = 31の2倍体と6倍体の存在が知られているものの，各地から4倍体が最も多く報告されている．今回，奄美大島と沖縄島のアラゲヒメワラビ4個体を調査したところ4倍体（2n = 124）であった．一方，アラゲヒメワラビの変種であるヒメワラビについては2倍体が東京都から1例，4倍体が栽培株（産地不詳）と中国杭州から各1例ずつ報告されている．今回調査した日本の7産地から得た8個体の染色体は，すべて2倍体（2n = 62）であった．Fig. 2にアラゲヒメワラビ群全体の細胞地理学的知見をまとめた．4倍体は熱帯域を中心に広く分布しているが，2倍体は日

本・台湾にのみ見いだされた．ミドリヒメワラビの染色体数については n = 61–62という報告があったが，今回 4 産地 6 個体で2n = 122を観察した．この染色体数は x = 31の 4 倍体である2n = 124から染色体が 2 本減少して生じたものと考えられる．

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